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IS 5921-9 (1988): Metal-Clad Base Materials for Printed Circuits for Use in Electronic and Telecommunication Equipment, Part 9: Epoxide Cellulose Paper Core, Epoxide Glass Cloth Surfaces Copper-Clad Laminated Sheet of Defined Flammability [LITD 5: Semiconductor and Other Electronic Components and Devices]



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Indian Standard

**SPECIFICATION FOR
METAL-CLAD BASE MATERIALS FOR
PRINTED CIRCUITS FOR USE IN ELECTRONIC
AND TELECOMMUNICATION EQUIPMENT**

**PART 9 EPOXIDE CELLULOSE PAPER CORE, EPOXIDE GLASS CLOTH SURFACES
COPPER-CLAD LAMINATED SHEET OF DEFINED FLAMMABILITY
(VERTICAL BURNING TEST)**

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Indian Standard

SPECIFICATION FOR METAL-CLAD BASE MATERIALS FOR PRINTED CIRCUITS FOR USE IN ELECTRONIC AND TELECOMMUNICATION EQUIPMENT

PART 9 EPOXIDE CELLULOSE PAPER CORE, EPOXIDE GLASS CLOTH SURFACES COPPER-CLAD LAMINATED SHEET OF DEFINED FLAMMABILITY (VERTICAL BURNING TEST)

0. FOREWORD

0.1 The Indian Standard (Part 9) was adopted by the Bureau of Indian Standards on 27 January 1988, after the draft finalized by the Printed Circuits Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard is to be used in conjunction with IS : 5921 (Part 1)-1983* which is a necessary adjunct to this standard.

0.3 While preparing this standard, assistance has been derived from the following:

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (*first revision*).

IEC Document 52 (Central Office) 258 Draft — Revision of Publication 249-2: Base material for printed circuits: Part 2 Specifications; Specification No. 9: Epoxide cellulose paper core, epoxide glass cloth surfaces copper clad laminated sheet of defined flammability (Vertical burning test).

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part 9) specifies the requirements for epoxide cellulose paper core, epoxide glass cloth surfaces copper clad laminated sheet of defined flammability (vertical burning test) for use in printed wiring in electronic and telecommunication equipment.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions as given in IS : 1885 (Part 6)-1978* shall apply.

3. MATERIALS AND CONSTRUCTION

3.0 The sheet consists of an insulating base with metal foil bonded to one or both sides.

3.1 Insulating Base — The base material shall be epoxide resin bonded composite laminate

*Electrotechnical vocabulary: Part 6 Printed circuits (*first revision*).

consisting of a cellulose paper core and glass cloth surface layers. Its flame resistance is defined in terms of flammability requirement specified in 8.3.

3.2 Metal Foil — The base material shall be covered with copper foil as specified in IS : 10922-1984*.

4. MARKING

4.1 The marking shall be in red colour in accordance with 3 of IS : 5921 (Part 1)-1983†. If letters or numbers are used, these shall be upright in the machine direction as shown below:

*Specification for copper foil for use in the manufacture of copper-clad base materials.

†Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (*first revision*).

Example

A	A	A	A	machine direction ↑ ↓	12	12	12
A	A	A	A		12	12	12
A	A	A	A		12	12	12
A	A	A	A		12	12	12

5. TESTS

5.1 The provisions of 4 of IS : 5921 (Part 1)-1983* shall apply except as modified by 5.1.1. The methods of tests shall be as described in IS : 5921 (Part 1)-1983*.

5.1.1 *Acceptance Tests* — In addition to the tests specified in 4.1.2 of IS : 5921 (Part 1)-1983*, flammability test shall also be carried out as acceptance test. Sampling plans and acceptance levels may be agreed upon between the purchaser and the supplier.

5.1.2 *Routine Tests* — The following tests may be carried out as routine tests:

- Visual examination, and
- Dimensions and tolerances.

6. ELECTRICAL PROPERTIES

6.1 The electrical properties shall meet the requirements given in Table 1.

7. NON-ELECTRICAL PROPERTIES OF COPPER-CLAD SHEET

7.1 Surface Finish of Copper-Clad Face

7.1.1 The copper-clad face shall be substantially free from blisters, wrinkles, pinholes, deep scratches, pits and resin. Any discoloration or contamination shall be readily removable with hydrochloric acid solution of density 1.02 g/cm³ or with a suitable organic solvent. The surface shall be inspected in accordance with 6.2 of IS : 5921 (Part 1)-1983*. The surface finish of the copper-clad face shall be such as not to conceal imperfections.

7.1.2 The surface of the copper foil shall be free from scratches of depth greater than 0.010 mm or one-fifth of the nominal thickness of the copper foil, whichever is the lower.

7.1.3 The total length of scratches of depth greater than 0.005 mm but not less than or equal to 0.010 mm, shall not exceed 1 m/m² of the total area of the sheet under test.

7.1.4 The area of any one or a number of pinholes in an area of 0.5 m² shall not exceed the area of a circle of diameter 0.125 mm.

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (first revision).

TABLE 1 ELECTRICAL PROPERTIES

(Clause 6.1)

SL No.	PROPERTY	TEST METHOD [CLAUSE OF IS : 5921 (PART 1)-1983*]	REQUIREMENTS
(1)	(2)	(3)	(4)
1.	Resistance of foil	5.1	As specified in IS : 10922-1984†
2.	Surface resistance while in humidity chamber	5.2	3 000 MΩ, Min
3.	Surface resistance after recovery	5.2	30 000 MΩ, Min
4.	Volume resistivity while in humidity chamber	5.2	1 000 MΩ m, Min
5.	Volume resistivity after recovery	5.2	5 000 MΩ m, Min
6.	Surface corrosion	5.7	No visible corrosion products in the gap
7.	Corrosion at the edge	5.8	Positive pole: Not worse than A/B; Negative pole: Not worse than 1:6
8.	Relative permittivity after damp heat and recovery	5.4	The average value shall not exceed <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">5.4 for 0.7 mm thickness</div> <div style="display: inline-block; vertical-align: middle;">5.2 for 1.6 mm thickness</div> <div style="display: inline-block; vertical-align: middle;">5.0 for 2.0 mm thickness</div> </div> For other thicknesses requirements for next smaller thickness shall apply
9.	Dielectric dissipation factor after damp heat and recovery	5.4	The average value shall exceed 0.045
10.	Surface resistance at 100°C	5.2.4	1 000 MΩ, Min
11.	Volume resistivity at 100 °C	5.2.4	100 MΩ m, Min

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (first revision).

†Specification for copper foil for use in the manufacture of copper-clad base materials.

7.1.5 No sheet shall have more imperfections of the types listed than those permitted by Table 2.

TABLE 2 TYPES, SIZES AND PERMITTED NUMBER OF IMPERFECTIONS

(Clause 7.1.5)

Sl. No.	TYPE	SIZE (LENGTH UNLESS OTHERWISE INDICATED)		NUMBER OF IMPERFECTIONS PERMITTED	
		Above mm	Not above mm	In any sheet of area about 1 m ²	In any area of 300 × 300 mm
(1)	(2)	(3)	(4)	(5)	(6)
1.	Inclusions	— 0.1 0.25	0.1 0.25 —	Any number 30 0	Any number 4 0
2.	Indentations	— 0.25 1.25	0.25 1.25 3.0 or width 1.0	Any number 13* 3*	Any number 3* 1†
		3.0 or width 1.0	—	0	0
3.	Bumps	— 0.1 4.0 or height 0.1	0.1 4.0 or height 0.1 —	Any number 10 0	Any number 2 0
4.	Wrinkles and blisters	Of any size	—	0	0

NOTE 1 — For sheets of area 1 m² or greater, the values in col 5 apply for any area of 1 m²; for the same sheets in any area of 300 × 300 mm, however, the values in col 6 apply. For sheets smaller than 1 m², col 6 apply for any area of 300 × 300 mm.

NOTE 2 — For cut panels, smaller sizes and others, the number of imperfections may be agreed upon between the purchaser and the supplier.

*The total for these sizes of indentations is 13.

†The total for these sizes of indentations is 3.

7.2 Thickness

7.2.1 The thickness of a sheet, including the metal foil, shall not depart at any point from the nominal thickness by more than the appropriate value given below. The coarse deviations shall apply unless the close deviations are specified.

Nominal Thickness (mm)	Deviation, ± (mm)	
	Coarse	Close
0.7	0.15	0.09
0.8	0.15	0.09
1.0	0.17	0.11
1.2	0.18	0.12
1.5	0.20	0.14
1.6	0.20	0.14
2.0	0.23	0.15
2.4	0.25	0.18
3.2	0.30	0.20
6.4	0.56	0.30

7.2.2 The thickness and tolerances do not apply to the outer 25 mm of the trimmed laminated sheet as supplied by the vendor. At least 90 percent of area, regardless of size, shall be within the tolerances given, and at no point shall the thickness vary from the nominal by a value greater than 125 percent of the specified tolerance.

7.2.3 For any nominal thickness within the range of nominal thickness 0.7 to 3.2 mm which is not given in the table of nominal thickness and corresponding deviations, the deviation applicable to the thickness shall be that for the next greater nominal thickness given in the table.

7.3 Bow and Twist — The bow and twist requirements are specified in Table 3.

7.4 Properties Related to the Copper Foil Bond — These properties are specified in Table 5.

7.5 Punching and Machining — Methods of test for punching properties and requirements for these are matters for agreement between the purchaser and the supplier.

7.6 Solderability

7.6.1 Plate Finish — When the sheet is tested as specified in 6.8 of IS : 5921 (Part 1)-1983* and in accordance with the time and temperature specified below, the soldered areas shall be covered with a smooth and bright solder coating. Scattered imperfections, such as pinholes, shall not occur on more than 5 percent of

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (first revision).

the surface and shall not be concentrated in one area. At least six specimens out of each batch of ten shall pass the test.

a) *Wetting*

Nominal Thickness (mm)	Thickness of Copper (μm)	Maximum Wetting Time (s)	Temperature ($^{\circ}\text{C}$)
0.7 to 1.6	35 (305 g/m ²)	2	235 ⁺⁵ ₋₀
Over 1.6 up to 6.4	35 (305 g/m ²)	3	235 ⁺⁵ ₋₀
0.7 to 6.4	70 (610 g/m ²)	3	235 ⁺⁵ ₋₀

b) *Dewetting* — Test specimens shall remain in contact with the molten solder for 5⁺¹₋₀ s at 235⁺⁵₋₀ $^{\circ}\text{C}$.

NOTE — For thicknesses of copper greater than 70 μm (610 g/m²), the wetting and dewetting times shall be agreed upon between the purchaser and the supplier.

8. NON-ELECTRICAL PROPERTIES OF BASE MATERIAL AFTER COMPLETE REMOVAL OF THE COPPER FOIL

8.1 *Appearance of Base Material* — The base material shall be substantially free from pits, holes, scratches, porosity and resin inclusions and substantially uniform in colour. A small amount of irregular variation of colour is permissible.

TABLE 3 BOW AND TWIST

(Clause 7.3)

SL No.	PROPERTY	TEST METHOD [CLAUSE OF IS : 5921 (PART 1) - 1983*]	REQUIREMENTS
(1)	(2)	(3)	(4)
1.	Bow	6.6	Shall not exceed the value given by the formula $D = d (L/1\ 000)^2$ mm, where L is the length of the straight edge in millimetres, and d is as given in Table 4
2.	Twist	6.7	Shall not exceed the value given by the formula $D = d (L/1\ 000)^2$ mm, where L is the distance in millimetres between the corner of the sheet not in contact with the horizontal surface and the diagonally opposite corner, and d is as given in Table 4

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TABLE 4 PARAMETERS RELATED TO BOW AND TWIST

SL No.	NOMINAL THICKNESS (mm)	COPPER FOIL ON ONE SIDE, d		COPPER FOIL ON BOTH SIDES, d , BOW AND TWIST	
		Bow not over 35 μm *	Twist		Not Over 70 μm *
			Over 35 μm * up to 70 μm *	Not over 70 μm *	
(1)	(2)	(3)	(4)	(5)	(6)
1.	0.8 to 1.2	55	105	30	25
2.	Over 1.2 to 1.6	38	75	25	20
3.	Over 1.6 to 3.2	32	55	15	15
4.	Over 3.2 to 6.4	27	40	15	15

NOTE 1 — Limits for laminates clad with foil of nominal thickness greater than 70 μm (610 g/m²) shall be subject to agreement between the purchaser and the supplier.

NOTE 2 — The requirements for bow and twist apply only to sheet sizes as manufactured and to cut pieces having neither length nor width less than 460 mm.

* 35 μm (= 305 g/m²); 70 μm (= 610 g/m²).

TABLE 5 PROPERTIES OF COPPER FOIL BOND

(Clause 7.4)

SL No.	PROPERTY	TEST METHOD [CLAUSE OF IS : 5921 (PART 1) - 1983*]	REQUIREMENTS
(1)	(2)	(3)	(4)
1.	Pull-off strength	6.11	Not less than 60 N
2.	Peel strength after heat shock of 10 s by methods (a) or (b) or 5 s by method (c)	6.10.4 (a), (b), or (c)	Not less than 1.2 N/mm for copper foil of 35 μm (305 g/m ²) and heavier
3.	Peel strength after dry heat at 100 $^{\circ}\text{C}$	6.10.5	Not less than 1.1 N/mm for copper foil of 18 μm (152 g/m ²)
4.	Peel strength after exposure to solvent vapour 1.1.1 trichlorethane	6.10.6	No blistering or delamination
NOTE — For solvents other than trichlorethane requirements shall be agreed upon between the purchaser and the supplier.			
5.	Peel strength after simulated plating	6.10.7	Not less than 0.8 N/mm
6.	Blistering after 10 s heat shock	6.9	No delamination or blistering

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8.2 Flexural Strength — This test is applicable to sheets not less than 1.0 mm of nominal thickness. The test should be carried out in accordance with 7.1 of IS : 5921 (Part 1)-1983*. The flexural strength shall not be less than 22 000 N/cm² for 1.0 mm thick, 20 000 N/cm² for 1.5 and 1.6 mm thick, and 18 000 N/cm² for 2.0 mm thick. For other thicknesses, it shall be agreed upon between the purchaser and the supplier.

8.3 Flammability — The vertical burning test shall be carried out in accordance with 7.2.3 of IS : 5921 (Part 1)-1983*. The following requirements shall be met:

- a) No specimen shall burn with flaming combustion for more than 10 s after either application of test flame,
- b) The total flaming combustion time shall not exceed 50 s for 10 flame applications for each set of 5 specimens,
- c) No specimen shall burn with flaming or glowing combustion up to the holding clamp,
- d) No specimen shall burn with glowing combustion which persists beyond 30 s after the second removal of the test flame, and
- e) The material shall not drip flaming particles which ignite the tissue paper.

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (*first revision*).

8.4 Water Absorption — It shall be measured in accordance with 7.3 of IS : 5921 (Part 1)-1983* and shall meet the following requirement. In case of thickness not included below, the requirement for next greater thickness shall apply:

<i>Nominal thickness</i> (mm)	<i>Water Absorption, Max</i> (mg)
0.7	20
0.8	20
1.0	20
1.2	20
1.5	20
1.6	20
2.0	21
2.4	22
3.2	25
6.4	32

9. PACKING

9.1 The sheets shall be adequately packed and protected in cases or crates to avoid damage in transit and during storage, for example, with interleaving packing material.

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (*first revision*).

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